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# MARKETING WESTERN FRUITS AND VEGETABLES

## Long-Term Outlook

Marketing Economics Division
Economic Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

## PREFACE

This report on fruits and vegetables covers one phase of work on the long-term outlook for marketing western agricultural commodities. Much of the information on new developments and methods in processing were obtained from the engineers, chemists, and industrial economists at three of the United States Department of Agriculture utilization research and development laboratories located at Albany, Calif.; Peoria, Ill.; and Philadelphia, Pa.

Donald Jackson of the Western Research Office, Marketing Economics Division, critically reviewed the manuscript and offered valuable suggestions.

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Washington, D. C. March 1963

## SUMMARY

The long-term outlook for marketing fruits and vegetables from the 11 western States is for continued growth. Total consumption of fruits and vegetables in the United States is projected to grow by at least a third from 1960 to 1975, and the Western Region should supply an increasing share of the total. This forecast is based on a projected increase of 31 percent in U. S. population and some increase in pounds consumed per person from 1960 to 1975. Alternative projected increases in population range from 21 to 36 percent, depending on assumptions as to fertility, mortality, and net migration rates. The Western Region now supplies about 65 percent of the noncitrus fruit, 45 percent of the vegetables, and 28 percent of the citrus fruit. Increases in the proportions of noncitrus fruits and vegetables and a small decrease in the proportion of citrus supplied by the West are in prospect.

The fruit and vegetable industry is changing rapidly. Processing is becoming more important, and new and better processed products are being developed. Consumer preferences are growing for good quality and convenient processed products. Rising incomes are stimulating this demand. Greatest growth in fruit and vegetable processing to 1975 is likely to be in freezing, combination freezing and dehydrating, and various improved methods of dehydrating. In these areas processing has grown rapidly in the last few years, and is likely to continue to grow for the next several years, though perhaps at a slower rate.

Growth in processing has important implications for the western fruit and vegetable industry. This growth should increase significantly the quantity of western products consumed in distant markets. Processing may reduce physical waste and transportation and other marketing costs relatively more for the western producer than for other producers. The specialized production, mild climate, and longer harvest season of the West also favor a larger increase in western processing.

# MARKETING WESTERN FRUITS AND VEGETABLES

## LONG-TERM OUTLOOK

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## INTRODUCTION

The Economic Research Service is presently making a study of western agriculture and of changes that are likely to occur by 1975. Three coordinate sectors of the study are: (1) Production capabilities and potentials, (2) consumption estimates, and (3) probable marketing developments and changes.

This report discusses factors that are likely to affect significantly the marketing of fruits and vegetables. Later work will deal with marketing other agricultural commodities and, finally, the results will be coordinated with the results in production and consumption to give a unified picture of changes in western agriculture by 1975.

Major attention in this report is directed toward conditions where the greatest changes seem likely to occur. This includes changes in uses of fruits and vegetables and new developments in processing, transportation, and other marketing functions.

## TRENDS IN FRUIT AND VEGETABLE USE 1/

Past trends in the marketing of a region's fruits and vegetables should give some indication of what to expect in the future. For example, the increasing extent to which western fruits and vegetables are marketed in the faster growing outlets, such as processing, may be an important factor for potential marketing increases in the region in the future.

### Vegetables 2/

U.S. commercial utilization of vegetables produced for both fresh and processed use has increased substantially in the last 20 years. Use of processed vegetables increased at a faster rate, and in 1960 was approximately equal to the quantity used

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1/ Trends in utilization of fruits and vegetables are based on statistics from the U. S. Department of Agriculture, Crop Reporting Board.

2/ Vegetables for processing include: Asparagus, green lima beans, snap beans, beets, cabbage, sweet corn, cucumbers, green peas, spinach, and tomatoes. Vegetables for fresh use include: Artichokes, asparagus, green lima beans, snap beans, beets, broccoli, brussels sprouts, cabbage, carrots, cauliflower, celery, sweet corn, cucumbers, eggplant, escarole, garlic, kale, lettuce, onions, green peas, green peppers, shallots, spinach, tomatoes, cantaloups, honeyball melons, honeydew melons, and watermelons.

fresh. 3/ During recent years the increase in production for the fresh market appears to have been slowing down. On the basis of these trends and developments in the food industry, one would expect the quantity of vegetables processed to exceed the quantity sold fresh by about 30 percent in 1975.

Processing by Regions.--Processing of vegetables has trended differently in the five major geographic regions (North Atlantic, North Central, South Atlantic, South Central and Western (11 western States). 4/ The 11 western States lead in vegetable processing with an increase from about 0.4 million tons in the early 1930's to about 4.4 million tons in 1962 (fig. 1). 5/ The North Central Region ranks second with an increase from about 1.25 to 2.90 million tons in the same period. The volume processed in each of the other three regions is now less than 1.0 million tons.

Until after World War II, the North Central Region was the largest processor of vegetables because of its dominance in canning. During World War II, processing increased rapidly in the West. In the late 1940's, this region became the major processor of vegetables because of its heavy participation in freezing as well as in canning.

If this rate of growth continues, by 1975 the Western Region could show a gain of about 65 percent in vegetable processing -- the largest gain of any region. This would give the Western Region about 50 percent of the total U. S. vegetable processing compared with about 43 percent in 1960. The North Central Region should also show further gains in processing, but the other three less specialized production regions will likely show little change. These estimates are based upon regional trends in processing and judgments of food engineers, food technologists, and others on the potential effect of new processing methods by 1975.

Of the individual vegetables processed in the West, tomatoes are by far the most important in terms of farm value (table 1). In the last 20 years, tomato processing in the West has increased 290 percent compared with about 75 percent of the United States as a whole. Since 1950, the largest percentage increases in vegetable processing in the West in order of importance, have been in lima beans, sweet corn, snap beans, tomatoes, and green peas. The seven most important vegetables for processing in the West are also those most important for the United States as a whole, but in a slightly different order (table 1). For the United States the first three in importance are tomatoes, snap beans, and green peas.

Fresh Market by Regions.--Commercial production of vegetables for the fresh market in the different regions also shows different trends. The Western Region produces the largest tonnage for fresh use with almost half of the U. S. total (fig. 2). Production in the West increased fairly steadily from 2.5 million tons in 1939 to 5.0 million tons in 1960. The South Atlantic Region ranks second in production with about 2.25 million tons in recent years. Production in the South Atlantic Region increased from about 1.25 million tons in 1939 to 2.6 million in 1955, but has declined slightly since. The three other regions have shown small increases in the last 20 years.

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3/ U. S. Department of Agriculture, Economic Research Service. The Vegetable Situation, TVS-142, table 6, p. 20, Oct. 1961.

4/ For some vegetables, such as broccoli, cauliflower, and carrots, utilization in processed forms is not reported separately, but included in the statistics on fresh use. However, the following figures on vegetable processing probably indicate the general trend of vegetable processing.

5/ In this section processed products are given in fresh equivalent weights.

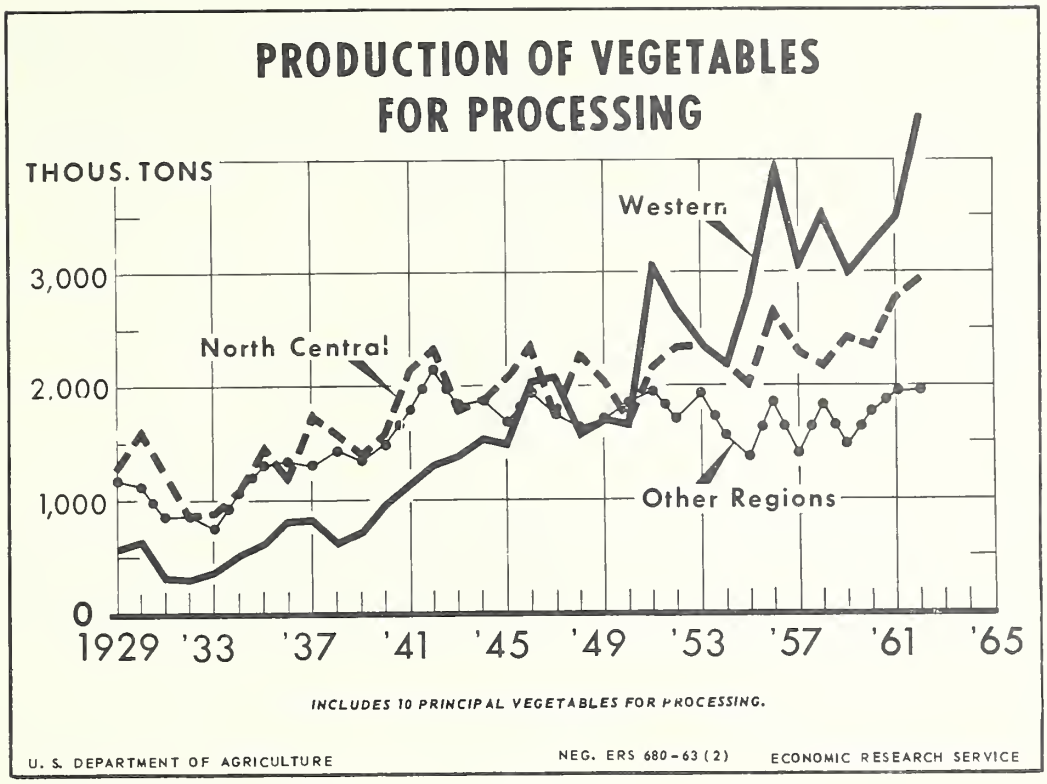


Figure 1

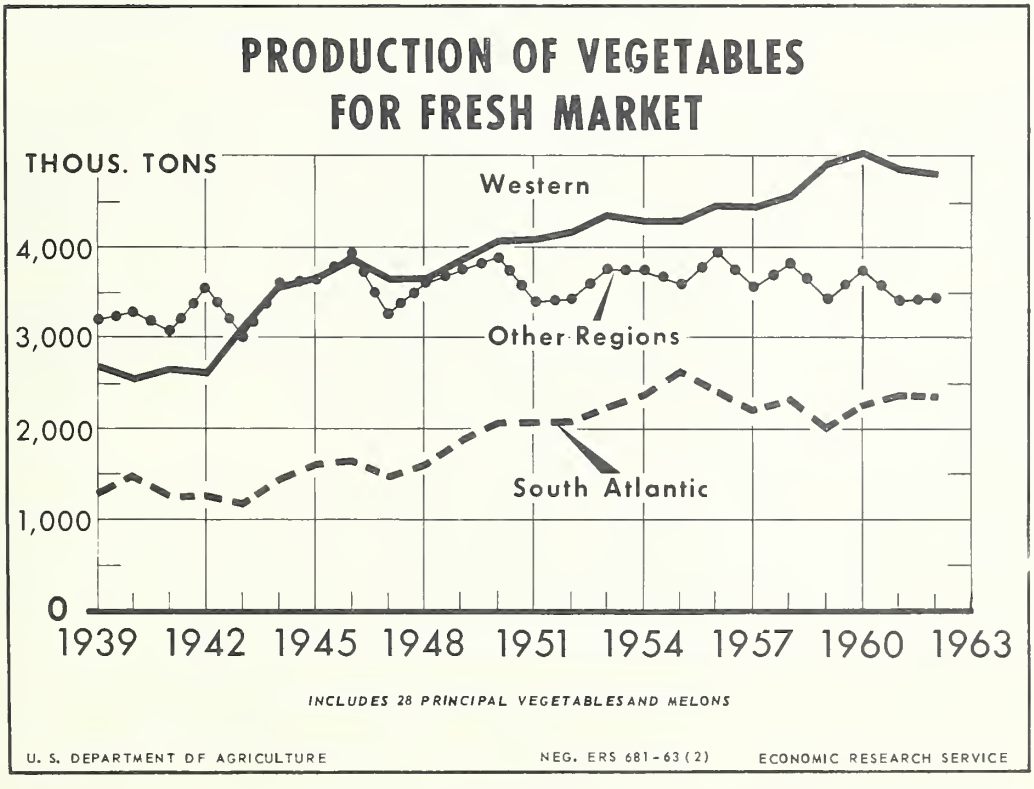


Figure 2

Table 1.--Vegetables for processing: Farm value in Western Region and percentage of total U. S. farm value, 7 principal vegetables, average 1959-50 1/

| Crop | Farm value in Western Region | Share of U.S. value |
|---|---|---|
| | Million dollars | Percent |
| Tomatoes | 49.1 | 52 |
| Snap beans | 16.0 | 38 |
| Asparagus | 15.8 | 62 |
| Green peas | 15.6 | 39 |
| Lima beans | 6.4 | 49 |
| Sweet corn | 5.9 | 21 |
| Cucumbers | 2.6 | 15 |

1/ Includes only those vegetables for which data on the value of processing in the Western Region are available. The quantity and value of broccoli, carrots, cauliflower, and a few other vegetables processed are not reported separately by the Crop Reporting Board, U. S. Department of Agriculture. These quantities are included in the statistics for fresh vegetables.

Source: U. S. Department of Agriculture, Crop Reporting Board. Vegetables--Processing, 1960. Vg. 3-2(60).

The 10 fresh vegetables produced in the West having the highest average farm value in 1959-60 are shown in table 2. Except for broccoli and asparagus, these vegetables are also among the most valuable fresh vegetables for the Nation as a whole.

Potatoes.--Potatoes are not included in tables 1 and 2, or in the totals shown in figures 1 and 2. About 7.5 million tons of potatoes were sold for fresh use and 3 million tons for processing in 1960. Thus, potatoes averaged about 40 percent of the fresh and 43 percent of the processed vegetable tonnage in the United States in 1959 and 1960.

Average U.S. production of potatoes remained at around 12.5 million tons from 1950 to 1960. Production in the 11 western States, however, increased 26 percent, or to 5.3 million tons. The largest increases in production were in Idaho, Washington, and Oregon; part of the increase probably can be attributed to the increase in processing of potatoes in Idaho and Washington.

The utilization of potatoes in the United States has changed rather sharply since 1940. About 25 percent of the potatoes used for food were processed in 1960 compared with less than 2 percent in 1940. Per capita consumption of processed potatoes has increased while fresh has declined. Total per capita consumption reached its low in 1956 and has increased slightly since then.

Three important types of processed potatoes and quantity used in 1960 were as follows:

(1) Potato chips - about 1,065,000 tons, or 43 percent of total processed (not including potatoes used in starch and flour).

Table 2.--Vegetables for fresh markets: Farm value in Western Region and percentage of total U. S. farm value, 10 principal vegetables, average 1959-60

| Crop | Farm value in Western Region | Share of U.S. value |
|---|---|---|
| | Million dollars | Percent |
| Lettuce | 121.2 | 89 |
| Tomatoes | 59.7 | 41 |
| Cantaloupes | 42.3 | 77 |
| Celery | 1/ 31.2 | 64 |
| Carrots | 1/ 29.0 | 74 |
| Onions | 1/ 23.4 | 43 |
| Broccoli | 2/ 14.0 | 79 |
| Asparagus | 10.8 | 62 |
| Watermelons | 9.9 | 23 |
| Sweet corn | 8.9 | 18 |

1/ Mostly fresh market use, but includes the farm value of some quantities processed.
2/ Includes quantities that were processed. These amounted to 63 percent of the 1959 and 73 percent of the 1960 production.

Source: U. S. Department of Agriculture, Crop Reporting Board. Vegetables--Fresh Market, 1960. Vg. 2-2(60).

(2) Frozen french fries - about 670,000 tons, or 27 percent of total processed.
(3) Dehydrated products, including instant mashed, diced, and sliced potatoes - about 505,000 tons, or 20 percent.

Production of all three major processed items has grown substantially during the last 5 years. From 1956 to 1960, production of potato chips increased about 50 percent and frozen french fries and dehydrated products about 200 percent. 6/

A survey by the University of Idaho of potato consumption patterns in two cities found that people who use processed potato products eat more potatoes than those who use only fresh potatoes. Because of the inconvenience of preparing fresh potatoes, they probably would not be used in many meals were it not for the availability of high-quality, convenient-to-use processed products. Convenience, improving quality, and increasing variety of processed potato products are likely to lead to their greater use.

Potato processing is concentrated in five States. 7/ Idaho is first with about 17 plants in operation for the 1960 crop and two or three more are now being built or planned. During the 1959 crop season, Idaho processed about 31 percent of its total crop of 40.5 million hundredweight. Washington is next in importance with

6/ U.S. Department of Agriculture, Crop Reporting Board, Irish Potatoes, Utilization of 1960 Crop With Comparisons, POT 1-3(9-61), p. 3, Sept. 14, 1961.
7/ Potato chip plants are omitted from the discussion which follows since they are located mainly near the large metropolitan centers. Chip production is market oriented; large quantities of potatoes are shipped from specialized production areas to chip plants.

five frozen french fry plants and another under construction. In 1959, Washington processed, exclusive of potato chips, about 6 percent of its total crop of over 8.5 million hundredweight. Maine is third with three frozen french fry plants and two more under construction. In 1959, Maine processed nearly 7 percent of its total crop of 37.0 million hundredweight. The Red River Valley of North Dakota and Minnesota has five flake plants and two flour plants. There is at least one frozen french fry plant under construction. Exclusive of chips, the area processed in 1959 about 6 or 7 percent of the total crop of about 23 million hundredweight. 8/

Idaho has had the fastest growth in potato processing and in 1960 processed about 60 percent of the U.S. total, including a major share of both frozen and dehydrated products. The relatively low cost of Idaho potatoes for processing in the 1950's, and the quality and yield of processed product per 100 pounds of fresh potatoes have favored this development.

## Noncitrus Fruits 9/

Sales of noncitrus fruits in fresh form in the United States differ in trend from sales of fresh vegetables. Fresh use has been declining slightly since the middle 1930's. Processed fruits as a whole, however, have shown a strong upward trend. Volume of fruit canned increased from about 700,000 tons in 1934 to about 1.9 million tons in 1960.

The U.S. Department of Agriculture reports the utilization of strawberries apart from the other noncitrus fruits. However, the U.S. strawberry production for fresh use decreased from 195,300 to 119,700 tons while strawberries processed increased from 27,400 to 116,200 tons from 1939-40 to 1959-60. In the Western Region strawberries for fresh use increased from 21,656 to 49,800 tons and strawberries processed from 23,800 to 95,400 tons in the same period.

The "other" processed fruit category, which includes fruit used for wine, juices, jams, brandy, and brined products, increased from about 800,000 tons in 1934 to 2 million tons in 1959-60. Grapes crushed for wine and juice accounted for about two-thirds of this category and for a large share of its increase.

Dried fruit increased to a peak of almost 2.6 million tons in 1943, but by 1960 dropped to about 1.4 million. The decline has been slight, however, since about 1950.

Freezing has been less important with noncitrus fruits than with vegetables. The amount frozen increased from about 80,000 tons in 1947 to about 200,000 tons in 1960.

The West does the major share of the Nation's fruit processing. This includes practically all of the drying and about 75 percent of both canning and other processing. For that reason, trends in the utilization of noncitrus fruits in the United States are similar to those in the West (fig. 3). Freezing is minor in all regions.

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8/ Feustel, I. C., Review of Potato Processing. Paper presented at Potato Growers Assoc. Calif. and Ariz. 17th Annual Convention, Bakersfield, Calif., Mar. 14, 1961. (Mimeographed.)

9/ Includes: Apples (commercial), peaches, nectarines, grapes, pears, cherries, apricots, plums, prunes, figs, dates, olives, avocados, cranberries, persimmons, pomegranates, and pineapple.

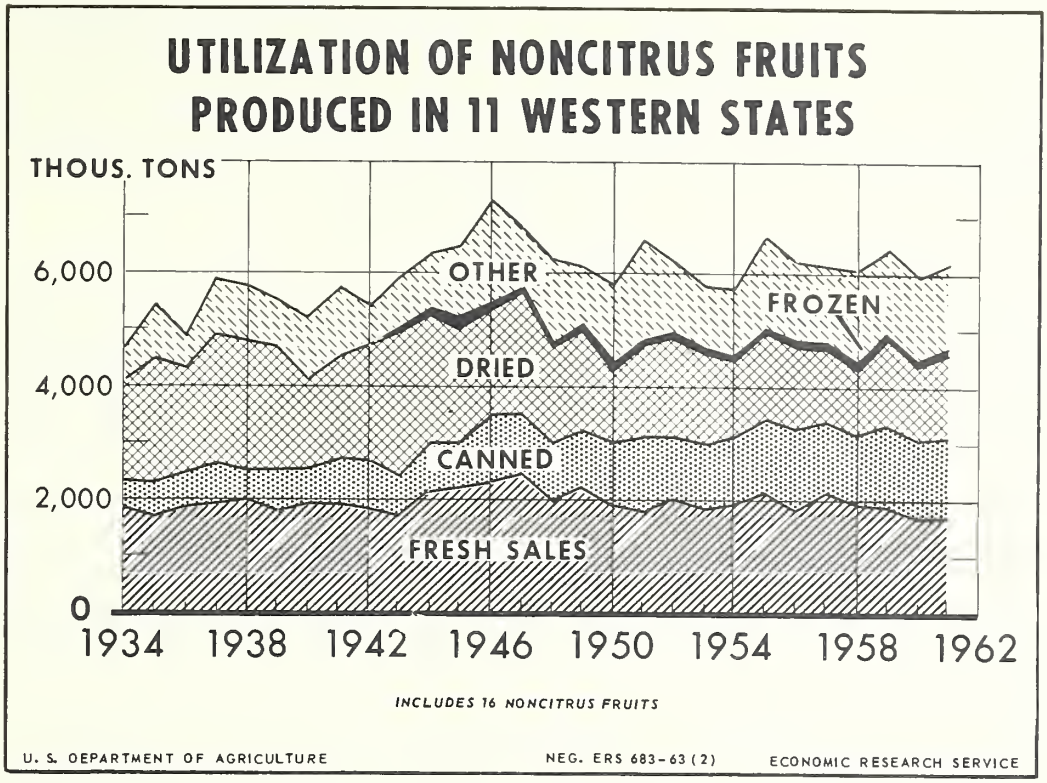


Figure 3

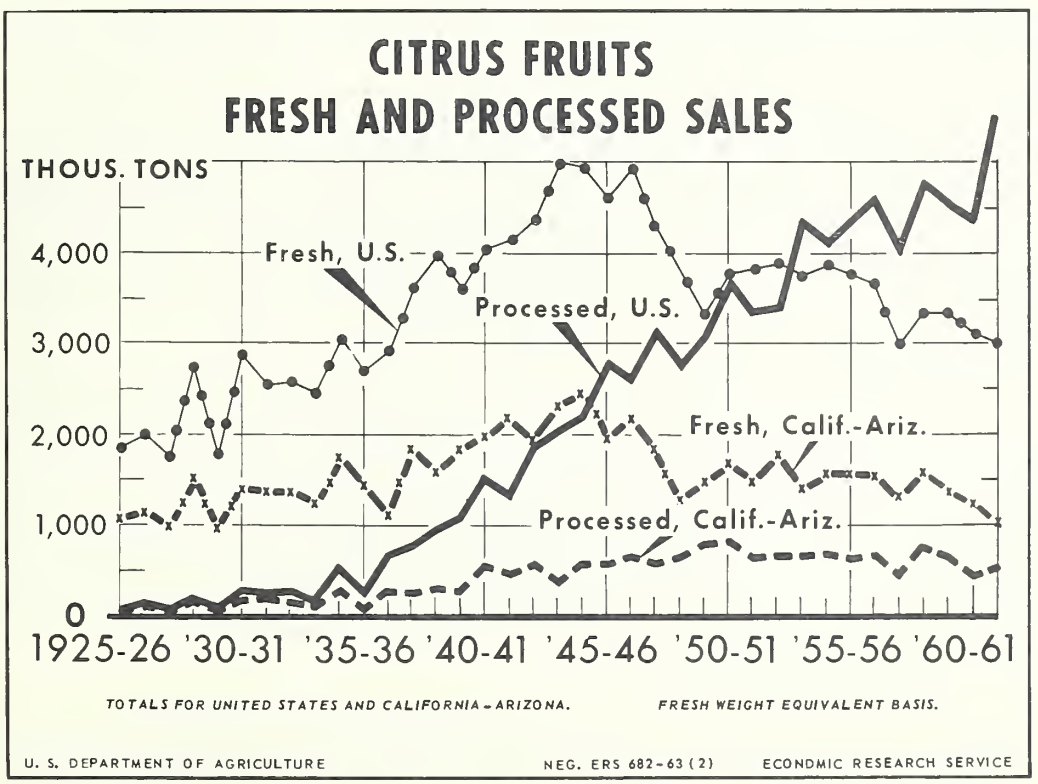


Figure 4

Fresh sales of western fruits account for about 50 percent of total U.S. fresh sales. Only 25 percent of western fruit is sold fresh, however, compared to about 70 percent for the rest of the United States.

Important noncitrus fruits produced in the Western Region average 1959-60 value, and percentage of U.S. value are given in table 3.

## Citrus Fruits

The growth in marketings of citrus fruits is the result of greater awareness of their nutritional value, larger consumer incomes, population growth, and development of frozen concentrated juices. The quantity of oranges marketed has nearly doubled in the last 20 years and amounted to about 5.5 million tons in 1960. Florida markets about 75 percent of the total, while Florida and California, together, market over 95 percent.

The quantity of grapefruit marketed has not changed much since 1940. Marketings reached a peak about 1946 but have declined slightly since then. Florida leads in grapefruit production with about 80 percent of the U.S. total. Florida, Arizona, and California have increased quantities marketed, but decreases in Texas resulting from freezes in 1949 and 1951, were almost enough to offset increases in these three States.

Marketings of lemons have increased about 55 percent in the last 20 years. Increases in processed lemon products accounted for most of the gain. Nearly all of the commercial lemon production has been in California, but production is increasing rapidly in Arizona.

The average farm value of citrus products in the Western Region and the share of United States value in the 1958-59 and 1959-60 crop years are given in table 4.

Major changes have occurred in the processing and use of citrus fruit. Only small quantities of citrus, principally single-strength, canned juices, were processed before 1935. However, in the late 1940's frozen concentrated orange juice became a commercial product and caused major shifts in utilization and production of processed citrus. By 1953-54, the quantity of citrus processed had surpassed the quantity marketed fresh, and the percentage processed has increased since then (fig. 4). Oranges account for about four-fifths of the tonnage of citrus fruits processed.

Several factors favor Florida in the production and marketing of processed orange products. Some of these factors are: (1) Lower cost of production per ton of oranges in Florida; (2) higher yield of juice from the Florida oranges; (3) lower transportation costs on the processed products compared to those for an equivalent quantity of fresh fruit enabling Florida to expand the market area for Florida oranges; and (4) urbanization of citrus-producing areas in Southern California. 10/ Mainly as a result of the increased use of frozen concentrated orange juice, Florida's share of total U.S. orange production increased from 43 percent in 1939-40 to 75 percent in 1959-60.

10/ Sinclair, Walton B., ed. The Orange, Its Biochemistry and Physiology. Univ. Calif. Press, 1961. (Table 8, p. 22, gives comparative costs of production for Florida and California.)

Table 3.--Noncitrus fruits: Farm value in Western Region and proportion of total U.S. farm value, average 1959-60

| Crop | Farm value in Western Region | Share of U.S. value |
|---|---|---|
| | Million dollars | Percent |
| Grapes | 142.4 | 84 |
| Apples | 72.3 | 32 |
| Peaches | 61.7 | 45 |
| Prunes | 58.0 | 100 |
| Strawberries | 49.8 | 57 |
| Pears | 47.8 | 90 |
| Apricots | 25.7 | 100 |
| Cherries | 22.5 | 52 |
| Plums | 14.7 | 95 |

Source: U.S. Department of Agriculture, Crop Reporting Board. Fruits, Noncitrus, 1960. Fr. Nt. 2-1(5-60).

Table 4.--Citrus fruit: Farm value in Western Region and proportion of total U.S. farm value, average 1958-59 and 1959-60

| Crop | Farm value in Western Region | Share of U.S. value |
|---|---|---|
| | Million dollars | Percent |
| Oranges | 117.3 | 31 |
| Lemons | 31.8 | 100 |
| Grapefruit | 8.0 | 13 |

Source: U.S. Department of Agriculture, Crop Reporting Board. Citrus Fruits, 1958-59 and 1959-60. Fr. Nt. 3-1(10-60).

Sales of processed citrus products grown in the Western Region increased steadily from 1925 to 1950, but since 1950 have leveled off at about 650,000 tons per year. Since about 1950, processed lemon products have increased considerably, but processed orange products have declined. Lemon and orange products each accounted for about 45 percent of the total processed production in the 1959-60 season.

Sales of fresh citrus fruits produced in the western States increased from about 1.1 million tons in the 1925-26 season to almost 2.5 million tons in 1944-45. Sales decreased rapidly in the late 1940's, but leveled off during the 1950's at about 1.5 million tons and remain at about this level. California-Arizona fresh citrus fruits accounted for slightly more than 50 percent of the total U.S. fresh sales in most years until 1940. Since 1940, they made up half or more of the total U.S. fresh sales in only 3 years.

In summary, based on past trends in citrus utilization, processed items, are likely to show the largest gains to 1975. Only small gains in citrus production are likely in the Western Region. United States citrus production should increase substantially by 1975 with most of the increase likely to be in Florida.

The trends in utilization and processing discussed above indicate the types of processing that are becoming more important and the proportions of fruits and vegetables that are being processed. This growth in processing affects the location of production, since processors tend to locate in specialized production areas where abundant, low-cost supplies of fruits and vegetables are grown. This demand for fruits and vegetables by processors, in turn, results in even larger quantities of specialized production.

Past developments in food technology and methods of processing, such as canning, quick freezing, and dehydrating have affected the utilization and location of fruit and vegetable production. New processing methods that are just beginning to be used commercially, or that are still in the experimental stage, may further affect the utilization and location of production by 1975. Some of these will now be considered.

## TECHNOLOGICAL DEVELOPMENTS IN FOOD PROCESSING

Present commercial food preservation depends on four general processes--heating, freezing, drying, and the addition of chemicals. Some of the newer methods combine two or more of the above four processes. Irradiation and treatment with hormones or antibiotics are still experimental.

Two new methods--freeze-drying and dehydrofreezing--utilize both freezing and drying. Freeze-drying first freezes the product, then removes about 98 percent of the moisture under high vacuum. Ice crystals are converted directly into vapor with a minimum change in cell structure and texture, and thus in quality of the product. Dehydrofreezing preserves by freezing after about 70 percent of the moisture, or about 50 percent of the original weight, is removed by dehydration. Dehydrofreezing, unlike freeze-drying, reduces the volume of the products. The product is reconstituted by cooking in water.

Dehydrofreezing has been applied successfully to apple slices, diced potatoes, diced carrots, peas, and pimientos. These products are used by several large commercial concerns in the manufacture of soups, baby foods, and various kinds of frozen foods.

The advantages of dehydrofreezing, resulting from the reduction in weight and volume, include potential savings in packaging, transportation, and storage costs over frozen foods, and improvement in quality over dehydrated foods. These savings are offset in part by the extra cost of processing. Food engineers and technologists believe that dehydrofreezing will become increasingly important in the next several years. Except for some differences in appearance, dehydrofrozen products are very nearly like the usual frozen products in quality and will likely substitute to a considerable degree for the regular quick-frozen foods. Because of savings in cost, dehydrofrozen products should increase the outlets and uses of frozen foods as a whole.

With freeze-drying--the other combination process--the product retains its original shape but is porous, dry, and brittle and absorbs moisture readily. It is reconstituted by merely soaking in water for a few minutes. For protection against light and moisture, the product should be packaged in a sturdy, opaque, hermetically-sealed container. It can then be kept up to 2 years with no danger of spoilage. The advantages of freeze-drying are:

(1) The reconstituted product retains near original flavor, color, odor, and texture.
(2) The product reconstitutes more easily than ordinary dehydrated foods.
(3) The product can be stored a long time without refrigeration.
(4) The handling, storage, and shipping costs are reduced both by the elimination of refrigeration and the reduction in weight.

The main disadvantage of freeze-drying is its high cost. Estimated costs range from 5 to 10 cents per pound, compared with less than 2 cents per pound for quick freezing. Several large companies are planning introduction of some freeze-dried products at the present time.

Freeze-drying will be commercially feasible if it can compete with other methods in costs and quality. It can more likely compete where cost of freeze-drying would be a small proportion of the value. Camping supplies and military food packets might provide limited, special additional outlets for freeze-dried foods. While this process is rather remarkable in its ability to maintain quality through dehydration, storage, and rehydration, even with perishable foods, freeze-dried foods are unlikely to be processed to a great extent over the next several years without a substantial breakthrough in technology to lower the cost.

In recent years, new developments in processes for dehydrating foods have increased the consumer acceptance of these products by improvements in ease of rehydration, in quality of the final product, and in convenience of use. Growth in the sales of dehydrated potato products provides an example of the changes resulting from improvements in dehydration. Private companies and the regional utilization research laboratories of the U.S. Department of Agriculture have developed and improved the methods of dehydrating potatoes. For example, processes for making granules and flakes for instant mashed potatoes are widely used, and quantity processed is growing rapidly. More and more potato slices are being dehydrated for use in scalloped and au gratin potato dishes. Dehydrated dices and cubes are used in the remanufacture of soups and other food products.

Two dehydration methods being developed, but still in the experimental stage, are vacuum-puff drying and foam-mat drying. In the former method, a vacuum is used to open up the structure of the product as an aid to drying. With foam-mat drying, a foaming agent is added and the material agitated into a foam which is then extruded in a mat-like layer on a perforated metal sheet. Heated air is blown

through the perforations creating craters in the foam mat. The craters greatly increase the drying surface and reduce drying time. The dried product is then ground to a powder, which reconstitutes rapidly without lumps. This process apears to have promise for such products as juices, tomato paste, mashed potatoes, and baby foods.

Dehydrated vegetables, fruit-juice powders, and other products are expected to become more important in the next few years. Because of the large potential reduction in transportation costs, the West, especially, should benefit from improvements in dehydration techniques.

Another processing method receiving attention, but having only limited use, is high-temperature, short-time aseptic canning. To minimize heat damage, the product is rapidly brought to a high temperature, around 285 degrees, for about 15 seconds. The sterilized food is then rapidly cooled and sealed in presterilized cans. Better flavor and quality resulting from the reduction in heat damage are the principal advantages of this process.

Irradiation of food has stirred the imagination with its possibilities. This process can be used either to sterilize or pasteurize food, depending on the dosage used, and may double or treble the storage life of fresh fruits and vegetables. Small doses may also be used to keep potatoes from sprouting.

Irradiation is still in the experimental stage because of several problems in its use. Because of the danger of irradiation to humans during processing, lead plates must be used to shield the rays. The high rates of irradiation needed to sterilize food and cut down on enzyme action may cause off-flavors or change the texture of the final product. The off-flavor is reduced slightly if ascorbic acid is present, if the food is frozen before irradiation, or if spices are added to the food. In addition, the package for irradiated food should be impermeable to organisms but still admit air. (If the food is pasteurized, rather than sterilized, however, the package does not need to be completely impermeable to organisms.) Finally, the cost of irradiating and packaging the food is high.

Because of the problems involved, the effort to produce commercial products has been decreased. Work on basic questions has continued, such as the effect of irradiation on the physical and chemical characteristics of the treated food. Irradiation is unlikely to become commercially feasible on a large scale in the next few years. It might become useful for special, high-value foods, such as oysters or meat, or for use by the Armed Forces, but a substantial breakthrough is needed for wider commercial uses. This could result, however, from the basic research now being done.

Other possible ways of lengthening the shelf life of foods are by increased use of chemicals, controlled-atmosphere storage, and use of plant hormones. Work is being done by a large industrial company on the use of a synthetic plant hormone, kinin, to keep plant cells virorous and thus increase the shelf life of vegetables.

Antibiotic preservation of food is another possibility and has been tried on such vegetables as broccoli, cauliflower, and spinach. Up until now, however, spoilage has not been controlled adequately enough by antibiotics to satisfy the Food and Drug Administration.

Convenience is an important advantage of most of the processed foods. This includes dehydrated, canned, and frozen fruits and vegetables, and prepared frozen foods. Rising consumer incomes and the growing number of women working outside

the home are increasing the demand for convenience foods of good quality. Food companies have capitalized on the growing demand for convenience by bringing out more new and improved convenience items.

In addition to home use, a further boost in the use of convenience foods probably will result from:

(1) Increased use of frozen prepared and dehydrated foods by restaurants, hotels, and other institutions. This might develop to the point where prepared frozen foods could be used almost entirely for the preparation of meals.
(2) Development of new and improved vending machines for prepared frozen foods; the foods may be heated rapidly by electronic heaters. These might be installed in small plants or in other locations about large cities.

The major area of growth in fruit and vegetable processing in the next 10 to 15 years in addition to canning would seem to be in freezing, including the related process of dehydrofreezing, and in various kinds of dehydration. Processing in these two areas has grown rapidly in the last few years, and is likely to continue, although perhaps at a slower rate.

## FACTORS AFFECTING FUTURE MARKETING OF WESTERN FRUITS AND VEGETABLES

For some fruits and vegetables, the Western Region may be better able to compete with other production areas by processing than by selling in the fresh market. For many fruits and vegetables, processing tends to lower the cost of marketing. By removing product trimmings and water and by reducing waste, volume and weight are reduced. Processing also preserves the quality and lengthens the storage and shelf life of the product. This tends to stabilize the marketing of fruits and vegetables by reducing its highly seasonal nature.

Past experience indicates that processing tends to develop in specialized areas of production. For example, the canning industry is concentrated in certain States in the Midwest, Pacific Coast, and North Atlantic regions. Freezing and drying of fruits and vegetables are heavily concentrated in the Pacific Coast States.

One vital requirement for the development of processing in an area is the ability to grown an abundant supply of fruits or vegetables with relatively low production costs. Parts of the Western Region have certain advantages in the production of fruits and vegetables for processing. The favorable climate, long-growing season, and productive, irrigated soils result in high yields and relatively stable production per land unit from year to year.

A long harvest season has cost-reduction possibilities in marketing by allowing processing plants to operate more hours per season and spread the overhead costs over more units processed. For example, California has a much longer harvest season for strawberries than other producing areas, which allows the freezing plants to operate more hours per season. A similar result can be accomplished by processing in the same plant fruits or vegetables that mature at different times.

The West also has some relative disadvantages in the production and processing

of fruits. Higher wages are paid in the West than in other production areas. In some cases labor may be productive enough to offset the high wages, but wage cost per unit processed may be higher in the West than in other regions. However, information on the productivity of labor in food processing by regions is not available.

Transportation cost is another disadvantage of the western grower and processor. Because of the bulkiness and perishability of fresh fruits and vegetables, transportation charges per hundredweight are higher than for most other farm products. The charge on western fruits and vegetables is especially high on shipments to eastern markets because of the long distances to market and has an important part in determining their competitive position. 11/ High transportation rates may tend to limit the marketing area, or the quantities marketed in certain areas. Increases in these costs may cause some shifting in the allocation of western fruits and vegetables from the more distant eastern to the closer western and midwestern markets. 12/

Higher transportation charges per unit on western fresh fruits and vegetables favor more processing of some of these products. Because processing reduces weight and eliminates waste, transportation costs are thereby lowered more for the West than for regions closer to the major eastern markets. Dehydrating of fruits and vegetables is another means of lowering transportation costs. Because of high transportation costs and probably lower quality of fresh fruits and vegetables in markets distant from western production areas, technological improvements in processing will mean that consumers located in these distant markets will probably purchase a larger proportion of total fruits and vegetables in processed form.

Rapid population growth in the Western Region, particularly in the Pacific Coast States and Arizona, is another factor likely to affect the movement of fruits and vegetables to markets. Projections by the Bureau of the total population of the 48 States in 1975 range from about 215 million to 245 million, depending on assumptions as to fertility, mortality, and net migration rates. Population of the 48 contiguous States in 1960 was about 180 million. A more rapid growth is expected in the West. Projected population in 1975 of the 11 Western States ranges from 37 to 42 million, or 17 percent of the U. S. total. This represents an increase from 27 million, or 15 percent of the total in 1960. Nevertheless, while the rapid population growth in the West will help the western grower, he will still be highly dependent on distant markets for his fruits and vegetables.

11/ This is not to imply that these charges are too high, since the cost of performing these transportation services is also higher.

12/ Changes in production and other marketing costs, however, may offset or accentuate the effects of changes in transportation costs.